mal fluid pocket **554** and an activated activating cell **560**. During the operation, thermal fluid pocket **554** increases its physical volume (or size) from its original state **556** to expanded thermal fluid pocket **554** when activating cell **560** is activated. When activating cell **560** is activated, it provides heat **562** to thermal fluid pocket **554** or **556** to expand the size of thermal fluid pocket **554** or **556**. Due to the expansion of thermal fluid pocket **554**, a localized portion **552** of insulated layer **506** is created. As soon as the temperature of the fluid in the thermal fluid pocket **554** cools down, the size of thermal fluid pocket **554** returns to its original state **556**. The change of size between original size of a thermal fluid pocket **556** and expanded size of thermal fluid pocket **554** generates a haptic effect. It should be noted that activating cell **560** could be an electric heater or an optical heater such as an infrared simulator. As such, an array of haptic cells using thermal fluid pockets **552** may be used to control the surface texture of touch sensitive surface of the interface device.

FIG. **6**(*a*) is a side view diagram of an interface device **600** illustrating an array of MEMS pumps **602** in accordance with one embodiment of the present invention. The array of MEMS pumps **602** can be used to implement tactile regions for controlling surface textures. Diagram **600** includes an insulated layer **606** and a haptic layer **612**. While the top surface of insulated layer **606** is configured to receive a touch or touches from a user, the bottom surface of insulated layer **606** is placed adjacent to the top surface of haptic layer **612**. The bottom surface of haptic layer **612** is, in one embodiment, placed adjacent to a display (not shown in FIG. **6**(*a*)), wherein haptic layer **612** and insulated layer **606** may be substantially transparent thereby objects or images displayed in the display can be seen through haptic layer **612** and insulated layer **606**. It should be noted that display is not a necessary component in order for the interface device to function.

Haptic layer **612**, in one embodiment, includes a grid of MEMS pumps **602**, which further includes at least one pocket **604**. Each MEMS pump **602** includes a pressurized valve **608** and a depressurized valve **610**. Pressurized valve **608** is coupled to an inlet tube **614** while depressurized valve **610** is coupled to an outlet tube **616**. In one embodiment, inlet tube **614**, which is under high liquid pressure, is used to pump liquid through pressurized valve **608** to expand pocket **604**. Similarly, outlet tube **616**, which is under low pressure, is used to release the liquid through depressurized valve **610** to release the pressure from pocket **604**. In one embodiment, MEMS pumps **602** can be coupled to the same pressurized liquid reservoir. In addition, pressurized valve **608** and depressurized valve **610** may be combined into one single valve for both inlet tube **614** and outlet tube **616**. It should be noted that inlet tube **614** and outlet tube **616** can also be combined into one tube.

A grid of MEMS pumps **602** includes an array of pressurized valves **608** and depressurized valves **610**, wherein pressurized valves **608** are coupled with a rear or a side mounted liquid reservoir under pressure while depressurized valves **610** are coupled to a rear or a side mounted depressurized liquid reservoir with low pressure. Valves **608**-**610** control the filling and emptying the liquid pockets **604** in MEMS pumps **602** to produce localized strain. An advantage of using pressurized liquid reservoir is to quickly deform the surface of insulated layer **606** and to maintain the deformation with minimal or no energy consumption (or expenditure). It should be noted that MEMS pump **602** can also use pressurized air or other gases to achieve similar results as liquid.

Device **600** further includes a set of control wires **617**-**618**, which can be used to control pressurized valve **608** and depressurized valve **610**, respectively. It should be noted that each valve in haptic layer **612** is addressable using electrical signals transmitted from wires or wireless network.

FIG. **6**(*b*) illustrates two diagrams of an interface device **620** and **650** having an array of MEMS pumps **604** in accordance with one embodiment of the present invention. Device **620** illustrates an activated pocket **623**, which includes an activated inlet valve **630** and a deactivated outlet valve **632**. During an operation, pocket **623** increases its physical volume (or size) from its original state **624** to its expanded pocket **623** when inlet valve **630** is activated. When inlet valve **630** is activated (or open) in response to electrical signal from wire **628**, inlet tube **625** pumps liquid **626** from pressurized reservoir to pocket **623**. Due to the expansion of pocket **623**, a localized strain **622** of insulated layer **606** is created.

Device **650** illustrates an activated MEMS pump returns from its expanded state of pocket **623** to the original state of pocket **653**. When depressurized valve **660** is activated, depressurized valve **660** releases liquid **656** from pocket **653** to low pressurized outlet **654**. It should be noted that depressurized valve **660** is controlled by at least one control signal via wire **658**. The change in volume between original size of pocket **604** and expanded size of pocket **623** generates haptic effects. As such, an array of MEMS pumps **602** may be used to control the surface texture of touch sensitive surface of the interface device.

FIG. **7** illustrates a side view diagram for an interface device **700** having an array of haptic cells **702** using variable porosity membrane **710** in accordance with one embodiment of the present invention. The porosity membrane **710** can be used to implement tactile regions for controlling surface textures. Device **700** includes an insulated layer **706** and a haptic layer **712**. While the top surface of insulated layer **706** is configured to receive inputs from a user, the bottom surface of insulated layer **706** is placed adjacent to the top surface of haptic layer **712**. The bottom surface of haptic layer **712** is, in one embodiment, placed adjacent to a display (not shown in FIG. **7**), wherein haptic layer **712** and insulated layer **706** may be substantially transparent thereby objects or images displayed in the display can be seen through haptic layer **712** and insulated layer **706**. It should be noted that display is not a necessary component in order for the interface device to function.

Haptic layer **712**, in one embodiment, includes a grid of haptic cells **702**, inlet valves **703**, and outlet valves **704**. Haptic cells **702**, in one embodiment, are pockets capable of containing fluid. Haptic layer **712** is similar to haptic layer **612** as shown in FIG. **6**(*a*) except that haptic layer **712** employs porosity membranes. While each inlet valve **703** is controlled by control signal(s) transmitted by wire **713**, each outlet valve **704** is controlled by electrical signals transmitted over a wire **714**. Every inlet valve **703** or outlet valve **704** employs at least one porosity membrane **710**. Porosity membranes **710** are coupled (or faced) to a liquid reservoir wherein each membrane **710** is configured to control how much liquid should enter and/or pass through membrane **710**. An advantage of using porosity membranes is to maintain the deformation of insulated layer **706** with minimal or no energy consumption. As such, a grid of haptic cells using variable porosity membrane **710** may be used to control the surface texture of touch sensitive surface of the interface device.

FIG. **8** is a side view of an interface device **800** having an array of haptic cells **802** using various resonant devices in accordance with one embodiment of the present invention. The array of haptic cells **802** can be used to implement tactile regions for controlling surface textures. Device **800** includes an insulated layer **806** and a haptic layer **812**. While the top surface of insulated layer **806** is configured to receive an input